

# SUBSEA: Systematic Underwater Biogeochemical Science and Exploration Analog

Completed Technology Project (2017 - 2020)



## Project Introduction

Our proposed effort will address the Science, Science Operations and Technology topics relevant to the PSTAR program. There is much to be learned by exploring Earth's Oceans that is directly relevant to Planetary Exploration; our planet's water is intimately connected to the larger story of the search for life and habitability in our Solar System and beyond. SUBSEA will address this potential through a partnership with the National Oceanographic and Atmospheric Administration and the Ocean Exploration Trust by leveraging their ship, the Nautilus, and associated telepresence mission infrastructure to 1) characterize the habitability of isolated seamounts and associated fluid flow as an analog to Ocean Worlds in our Solar System, and 2) to develop Low Latency Telerobotic (LLT) mission concepts by studying the high-fidelity, 'flight like' operational analog that Nautilus missions represent. a) Science – SUBSEA is anchored by a Science program that will 1) broaden our understanding of the potential habitability of other Ocean Worlds in our Solar System, and 2) characterize novel deep sea environments on our own planet. Specifically, SUBSEA will investigate the habitability of hydrothermal systems on Ocean Worlds that may lack plate tectonics. We will do so by examining how geochemical disequilibria arising from a range of water-rock reactions at two relevant analog locations (the isolated submarine volcanoes of the Lō`ihi Seamount off Hawai`i and the Teahitia Seamount off Tahiti) can drive the availability of energy sources to sustain a diverse set of microbial metabolisms, and where and for how long such conditions are most likely to persist. b) Science Operations: The SUBSEA Science Operations research program will leverage the high-fidelity LLT analog environment of the Nautilus telepresence mission architecture and the real (non-simulated) SUBSEA science activities to evaluate and identify specific concepts of operations (ConOps) and capabilities that will have enabling and enhancing value for science-driven LLT exploration of Deep Space and Mars. Nautilus operations are supported by a small onboard crew enhanced via telepresence by a much larger shore-side science team. We will conduct our science under simulated mission conditions (including communication latencies) that are based on current architectural assumptions for LLT mission concepts. c) Technology: SUBSEA will use prototype information technologies that will be evaluated and iterated upon based on their ability to support science-driven LLT operations. We will achieve this by integrating our Exploration Ground Data Systems (xGDS) software with Nautilus telepresence mission support systems, and then systematically evaluating the technology during our SUBSEA field campaigns. xGDS will provide human/robotic software functionality to support integration and visualization of diverse data products relevant to future human exploration of deep space. Our proposed work will significantly impact and contribute to the state of knowledge in a) the habitability and energetics of an expanded range of analog vent systems for Ocean Worlds, b) methods for efficiently, productively and safely conducting science-driven Low Latency Telerobotics in representative deep space environments such as Mars, and c) the capability to support distributed



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## Organizational Responsibility

### Responsible Mission Directorate:

Science Mission Directorate (SMD)

### Responsible Program:

Planetary Science and Technology Through Analog Research

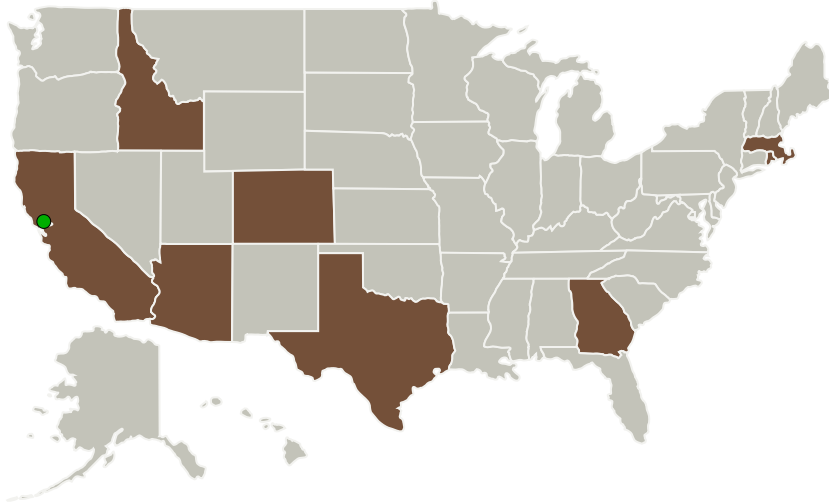
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science teams as they conduct long duration telerobotic missions with visual observation, instrument data and sample collection under time delay.

## Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
● Ames Research Center(ARC)	Supporting Organization	NASA Center	Moffett Field, California

Primary U.S. Work Locations	
Arizona	California
Colorado	Georgia
Idaho	Massachusetts
Rhode Island	Texas

## Project Management

**Program Director:**

Carolyn R Mercer

**Program Manager:**

Sarah K Noble

**Principal Investigator:**

Darlene S Lim

**Co-Investigators:**

Christopher R German  
Zara Mirmalek  
Andrew F Abercromby  
Tamar E Cohen  
Matthew J Miller  
Everett L Shock  
Nicole Raineault  
Mathew C Deans  
David Lees  
Sandra Owen  
Katherine L Bell  
John A Breier  
Julie A Huber  
Steven P Chappell  
Shannon E Nawotniak

## Technology Areas

**Primary:**

- TX04 Robotic Systems
  - └ TX04.2 Mobility
    - └ TX04.2.4 Surface Mobility

## Target Destination

Others Inside the Solar System